What is claimed is:

Claims

1. A non-contact position sensor comprising:

a first stator having first and second magnet facing sides;

a second stator having a magnet facing side aligned with the first and second magnet facing sides of the first stator along a locus;

a hall element between the first and second stators; and

first and second magnets located next to each other along the locus opposite the first and second magnet facing sides of the first stator and the magnet facing side of the second stator so as to move freely along the locus.

2. The non-contact position sensor of claim 1, wherein the locus is a straight line locus, and the first and second magnets are plate-shaped magnets supported by a slider which is slidable along the locus.

3. The non-contact position sensor of claim 1, wherein the locus is a circular arc-shaped locus, and the first and second magnets are curved plate-shaped magnets supported by a rotor which is rotatable along the locus.

4. The non-contact position sensor of claim 2, further comprising:

a case, the first and second stators being housed in the case so that a fixed distance is maintained between the first and second magnets and the first and second stators; and

a bearing supporting the slider in a freely slidable manner.

5. The non-contact position sensor of claim 4, further comprising at least one roller cooperating with the slider to allow the slider to slide.

6. The non-contact position sensor of claim 5, wherein the first and second magnets together have a center of gravity, said at least one roller being a pair of rollers positioned substantially at the center of gravity in a direction orthogonal to a sliding direction of the slider.

7. The non-contact position sensor of claim 3, further comprising:

a case housing the first and second stators; and

a guide pin in the case and supporting the first stator, the rotor being axially supported in a freely rotatable manner at the guide pin .

8. The non-contact position sensor of claim 3, further comprising:

a case housing the first and second stators; and

a hollow coupling section formed at the rotor, wherein the case has a projection section fitting with the hollow coupling section.

9. The non-contact position sensor of claim 2, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sa1 and Sa2, respectively, a length of the magnet facing side of the second stator is Sa3, lengths of the first and second magnets are Ma1 and Ma2, respectively, a gap between the first and second magnets is Ga1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Ga2 and Ga3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Ma1 = Ma2 = 2L - Ga1$$

$$Ga1 = Ga2 = Ga3$$

$$Sa1 = Sa2 = Sa3 = Ma1$$

10. The non-contact position sensor of claim 2, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sb1 and Sb2, respectively, a length of the magnet facing side of the second stator is Sb3, lengths of the first and second magnets are Mb1 and Mb2, respectively, a gap between the first and second magnets is Gb1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Gb2 and Gb3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Mb1 = Mb2 = L - Gb1/2$$

$$Gb1 = Gb2 = Gb3$$

$$Sb1 = Sb2 = Sb3/2 = Mb1$$

11. The non-contact position sensor of claim 3, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator are $S\theta a1$ and $S\theta a2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta a3$, central

angles of the first and second magnets are $M\theta a1$ and $M\theta a2$, respectively, a gap between the first and second magnets is $G\theta a1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta a2$ and $G\theta a3$, respectively, and a stroke of the first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta a1 = M\theta a2 = 2\theta - G\theta a1$$

$$G\theta a1 = G\theta a2 = G\theta a3$$

$$S\theta a1 = S\theta a2 = S\theta a3 = M\theta a1$$

12. The non-contact position sensor of claim 3, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator are $S\theta b1$ and $S\theta b2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta b3$, central angles of the first and second magnets are $M\theta b1$ and $M\theta b2$, respectively, a gap between the first and second magnets is $G\theta b1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta b2$ and

$G\theta b3$, respectively, and a stroke of first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta b1 = M\theta b2 = \theta - G\theta b1/2$$

$$G\theta b1 = G\theta b2 = G\theta b3$$

$$S\theta b1 = S\theta b2 = S\theta b3/2 = M\theta b1$$

13. The non-contact position sensor of claim 2, wherein a gap between the first and second stators into which the hall element is inserted, a gap between the first and second magnets, a gap between the first magnet facing side of the first stator and the magnet facing side of the second stator, and a gap between the magnet facing side of the second stator and the second magnet facing side of the first stator are substantially equal.

14. The non-contact position sensor of claim 2, wherein width in a direction orthogonal to the locus of the first and second stators and width in a direction orthogonal to the locus of the first and second magnets is substantially the same.

15. The non-contact position sensor of claim 3, wherein width in a direction orthogonal to the locus of the first and second stators and width in a direction orthogonal to the locus of the first and second magnets is substantially the same.

16. The non-contact position sensor of claim 1, wherein there is no gap in the first stator between the first and second magnet facing sides.

17. An apparatus comprising:

a non-contact position sensor including

a first stator having first and second magnet facing sides, and

a second stator having a magnet facing side between the first and second magnet facing sides of the first stator and aligned with the first and second magnet facing sides of the first stator along a locus.

18. The apparatus of claim 17, wherein the locus is a straight line locus.

19. The apparatus of claim 17, wherein the locus is a circular arc-shaped locus.

20. The apparatus of claim 17, wherein the non-contact position sensor is a linear sensor.

21. The apparatus of claim 17, wherein the non-contact position sensor is a rotary sensor.

22. The apparatus of claim 17, wherein the non-contact position sensor further includes

first and second magnets along the locus opposite the first and second magnet facing sides of the first stator and the magnet facing side of the second stator and movable along the locus.

23. The apparatus of claim 22, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sa1 and Sa2, respectively, a length of the magnet facing side of the second stator is Sa3, lengths of the first and second magnets are Ma1 and Ma2, respectively, a gap between the first and second magnets is Ga1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Ga2 and Ga3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Ma1 = Ma2 = 2L - Ga1$$

$$Ga1 = Ga2 = Ga3$$

$$Sa1 = Sa2 = Sa3 = Ma1.$$

24. The apparatus of claim 22, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sb1 and Sb2, respectively, a length of the magnet facing side of the second stator is Sb3, lengths of the first and second magnets are Mb1 and Mb2, respectively, a gap between the first and second magnets is Gb1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Gb2 and Gb3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Mb1 = Mb2 = L - Gb1/2$$

$$Gb1 = Gb2 = Gb3$$

$$Sb1 = Sb2 = Sb3/2 = Mb1.$$

25. The apparatus of claim 22, wherein the locus is a circular arc-shaped locus, the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator are $S\theta a1$ and $S\theta a2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta a3$, central angles of the first and second magnets are $M\theta a1$ and $M\theta a2$, respectively, a gap between the first and second magnets is $G\theta a1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta a2$ and $G\theta a3$, respectively, and a stroke of the first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta a1 = M\theta a2 = 2\theta - G\theta a1$$

$$G\theta a1 = G\theta a2 = G\theta a3$$

$$S\theta a1 = S\theta a2 = S\theta a3 = M\theta a1.$$

26. The apparatus of claim 22, wherein the locus is a circular arc-shaped locus, the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator

are $S\theta b1$ and $S\theta b2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta b3$, central angles of the first and second magnets are $M\theta b1$ and $M\theta b2$, respectively, a gap between the first and second magnets is $G\theta b1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta b2$ and $G\theta b3$, respectively, and a stroke of first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta b1 = M\theta b2 = \theta - G\theta b1/2$$

$$G\theta b1 = G\theta b2 = G\theta b3$$

$$S\theta b1 = S\theta b2 = S\theta b3/2 = M\theta b1.$$

27. The apparatus of claim 22, wherein width in a direction orthogonal to the locus of the first and second stators and width in a direction orthogonal to the locus of the first and second magnets is substantially the same.

28. The apparatus of claim 22, wherein

the non-contact position sensor includes a hall element, and

a gap between the first and second stators in which the hall element is positioned, a gap between the first and second magnets, a gap between the first magnet facing side of the

first stator and the magnet facing side of the second stator, and a gap between the magnet facing side of the second stator and the second magnet facing side of the first stator are substantially equal.

29. The apparatus of claim 17, wherein there is no gap in the first stator between the first and second magnetic facing sides.

30. The apparatus of claim 20, wherein there is no gap in the first stator between the first and second magnetic facing sides.

31. The apparatus of claim 21, wherein there is no gap in the first stator between the first and second magnetic facing sides.

32. An apparatus comprising:

a non-contact sensor including a magnet having a range of movement from a first position to a second position with a third position between the first and second positions, a first stator having first and second magnet facing sides, a second stator having a magnet facing side, and a hall element, information being determined in accordance with changes in magnetic flux in the hall element corresponding to changes in magnetic fields passing

through the hall element due to movement of the magnet, wherein the magnet, the first stator, the second stator and the hall element are arranged so that,

when the magnet is in the third position, a first magnetic circuit passes through the first and second magnet facing sides of the first stator, but does not pass through the second stator or the hall element, and a second magnetic circuit passes through the magnet facing side of the second stator and the magnet, but does not pass through the first stator or the hall element,

when the magnet is at the first position, a magnetic circuit passes through the second magnet facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but does not pass through the first magnet facing side of the first stator, and

when the magnet is at the second position, a magnetic circuit passes through the first magnet facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but does not pass through the second magnet facing side of the first stator.

33. The apparatus of claim 32, wherein the sensor is a linear sensor.

34. An apparatus comprising:

a non-contact sensor including a magnet having a range of movement from a first position to a second position with a third position between the first and second positions, a first stator having first and second magnet facing sides, a second stator having a magnet facing side, and a hall element, information being determined in accordance with changes in magnetic flux in the hall element corresponding to changes in magnetic fields passing through the hall element due to movement of the magnet, wherein the magnet, the first stator, the second stator and the hall element are arranged so that,

when the magnet is in the third position, a first magnetic circuit passes through the first and second magnet facing sides of the first stator and the magnet, but does not pass through the second stator or the hall element, and a second magnetic circuit passes through the magnet facing side of the second stator and the magnet, but does not pass through the first stator or the hall element,

when the magnet is at the first position, a first magnetic circuit passes through the second magnet facing side of the first stator, the magnet facing side of the first stator and the magnet, but does not pass through the first magnet facing side of the first stator or the hall element, second and third magnetic circuits each pass through the second magnet facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but do not pass through the first magnet facing side of the first stator, and a fourth magnetic circuit passes through the second magnet facing side of the first stator

and the magnet, but does not pass through the first magnet facing side of the first stator, the magnet facing side of the second stator or the hall element, and

when the magnet is at the second position, a first magnetic circuit passes through the first magnet facing side of the first stator, the magnet facing side of the first stator and the magnet, but does not pass through the second magnet facing side of the first stator or the hall element, second and third magnetic circuits each pass through the first magnet facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but do not pass through the second magnet facing side of the first stator, and a fourth magnetic circuit passes through the first magnet facing side of the first stator and the magnet, but does not pass through the second magnet facing side of the second stator, the magnet facing side of the second stator or the hall element.

35. The apparatus of claim 34, wherein the sensor is a linear sensor.

36. The apparatus of claim 34, wherein the sensor is a rotary sensor.

37. An apparatus comprising:

a non-contact sensor including a magnet having a range of movement from a first position to a second position with a third position between the first and second positions, a

first stator having first and second magnet facing sides, a second stator having a magnet facing side, and a hall element, information being determined in accordance with changes in magnetic flux in the hall element corresponding to changes in magnetic fields passing through the hall element due to movement of the magnet, wherein the magnet, the first stator, the second stator and the hall element are arranged so that,

when the magnet is in the third position, a magnetic circuit passes through the magnet facing side of the second stator and the magnet, but does not pass through the first stator or the hall element,

when the magnet is at the first position, a first magnetic circuit passes through the second magnet facing side of the first stator, the magnet facing side of the second stator and the magnet, but does not pass through the first magnet facing side of the first stator or the hall element, and a second magnetic circuit passes through the second magnet facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but does not pass through the first magnet facing side of the first stator, and

when the magnet is at the second position, a first magnetic circuit passes through the first magnet facing side of the first stator, the magnet facing side of the second stator and the magnet, but does not pass through the second magnet facing side of the second stator or the hall element, and a second magnetic circuit passes through the first magnet

facing side of the first stator, the magnet facing side of the second stator, the hall element and the magnet, but does not pass through the second magnet facing side of the first stator.

38. The apparatus of claim 37, wherein the sensor is a linear sensor.

39. The apparatus of claim 37, wherein the sensor is a rotary sensor.

40. An apparatus comprising:

a non-contact rotary position sensor having an output characteristic angle with a cycle settable greater than 180°.

41. The apparatus of claim 40, wherein the non-contact rotary position sensory has an output characteristic angle with a cycle settable between 180° and 220°.

42. The apparatus of claim 40, wherein the non-contact rotary position sensory has an output characteristic angle with a cycle settable between 180° and 240°.

43. A non-contact position sensor comprising:

a first stator having first and second magnet facing sides;

a second stator having a magnet facing side aligned with the first and second magnet facing sides of the first stator along a locus;

a hall element between the first and second stators; and

at least one magnet opposite at least one of the group consisting of the first magnet facing side of the first stator, the second magnet facing side of the first stator and the magnet facing side of the second stator.

44. The non-contact position sensor of claim 43, wherein said at least one magnet comprises first and second magnets positioned along the locus opposite the first and second magnet facing sides of the first stator and the magnet facing side of the second stator so as to move freely along the locus, the locus being a straight line locus, the first and second magnets being plate-shaped magnets supported by a slider which is slidable along the locus.

45. The non-contact position sensor of claim 43, wherein said at least one magnet comprises first and second magnets positioned along the locus opposite the first and second magnet facing sides of the first stator and the magnet facing side of the second stator so as to move freely along the locus, the locus being a circular arc-shaped locus, and the

first and second magnets being curved plate-shaped magnets supported by a rotor which is rotatable along the locus.

46. The non-contact position sensor of claim 44, further comprising:

a case, the first and second stators being housed in the case so that a fixed distance is maintained between the first and second magnets and the first and second stators; and

a bearing supporting the slider in a freely slidable manner.

47. The non-contact position sensor of claim 46, further comprising at least one roller cooperating with the slider to allow the slider to slide.

48. The non-contact position sensor of claim 47, wherein the first and second magnets together have a center of gravity, said at least one roller being a pair of rollers positioned substantially at the center of gravity in a direction orthogonal to a sliding direction of the slider.

49. The non-contact position sensor of claim 45, further comprising:

a case housing the first and second stators; and

a guide pin in the case and supporting the first stator, the rotor being axially supported in a freely rotatable manner at the guide pin .

50. The non-contact position sensor of claim 45, further comprising:

a case housing the first and second stators; and

a hollow coupling section formed at the rotor, wherein the case has a projection section fitting with the hollow coupling section.

51. The non-contact position sensor of claim 44, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sa1 and Sa2, respectively, a length of the magnet facing side of the second stator is Sa3, lengths of the first and second magnets are Ma1 and Ma2, respectively, a gap between the first and second magnets is Ga1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Ga2 and Ga3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Ma1 = Ma2 = 2L - Ga1$$

$$Ga1 = Ga2 = Ga3$$

$$Sa1 = Sa2 = Sa3 = Ma1$$

52. The non-contact position sensor of claim 44, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, lengths of the first and second magnet facing sides of the first stator are Sb1 and Sb2, respectively, a length of the magnet facing side of the second stator is Sb3, lengths of the first and second magnets are Mb1 and Mb2, respectively, a gap between the first and second magnets is Gb1, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are Gb2 and Gb3, respectively, and a stroke of the first and second magnets is 2L, so that the following relationships are satisfied

$$Mb1 = Mb2 = L - Gb1/2$$

$$Gb1 = Gb2 = Gb3$$

$$Sb1 = Sb2 = Sb3/2 = Mb1$$

53. The non-contact position sensor of claim 45, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and

second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator are $S\theta a1$ and $S\theta a2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta a3$, central angles of the first and second magnets are $M\theta a1$ and $M\theta a2$, respectively, a gap between the first and second magnets is $G\theta a1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta a2$ and $G\theta a3$, respectively, and a stroke of the first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta a1 = M\theta a2 = 2\theta - G\theta a1$$

$$G\theta a1 = G\theta a2 = G\theta a3$$

$$S\theta a1 = S\theta a2 = S\theta a3 = M\theta a1$$

54. The non-contact position sensor of claim 45, wherein the first and second magnet facing sides of the first stator are located in a symmetrical manner at first and second sides, respectively, of the magnet facing side of the second stator, central angles of the first and second magnet facing sides of the first stator are $S\theta b1$ and $S\theta b2$, respectively, a central angle of the magnet facing side of the second stator is $S\theta b3$, central angles of the first and second magnets are $M\theta b1$ and $M\theta b2$, respectively, a gap between

the first and second magnets is $G\theta b1$, gaps between the first magnet facing side of the first stator and the magnet facing side of the second stator and between the magnet facing side of the second stator and the second magnet facing side of the first stator are $G\theta b2$ and $G\theta b3$, respectively, and a stroke of first and second magnets is 2θ, so that the following relationships are satisfied

$$M\theta b1 = M\theta b2 = \theta - G\theta b1/2$$

$$G\theta b1 = G\theta b2 = G\theta b3$$

$$S\theta b1 = S\theta b2 = S\theta b3/2 = M\theta b1$$

55. The non-contact position sensor of claim 44, wherein a gap between the first and second stators into which the hall element is inserted, a gap between the first and second magnets, a gap between the first magnet facing side of the first stator and the magnet facing side of the second stator, and a gap between the magnet facing side of the second stator and the second magnet facing side of the first stator are substantially equal.

56. The non-contact position sensor of claim 44, wherein width in a direction orthogonal to the locus of the first and second stators and width in a direction orthogonal to the locus of the first and second magnets is substantially the same.

57. The non-contact position sensor of claim 45, wherein width in a direction orthogonal to the locus of the first and second stators and width in a direction orthogonal to the locus of the first and second magnets is substantially the same.

58. The non-contact position sensor of claim 43, wherein there is no gap in the first stator between the first and second magnet facing sides.

59. The non-contact position sensor of claim 43, wherein said at least one magnet comprises at least two magnets.

60. The non-contact position sensor of claim 43, wherein each magnet of said at least one magnet moves freely along the locus.

61. The non-contact position sensor of claim 43, wherein said at least one magnet comprises at least two magnets which move freely along the locus.